

CONGRESS AT BOLTON, 1887.



LECTURE TO THE CONGRESS.  
ON THE PREVENTION OF CONSUMPTION.

BY

ARTHUR RANSOME, M.D., F.R.S.

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# Sanitary Institute of Great Britain.

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*Congress at Bolton.*

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## ON THE PREVENTION OF CONSUMPTION.

### LECTURE TO CONGRESS,

*September 22nd, 1887,*

BY ARTHUR RANSOME, M.D., F.R.S.

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WHEN I was asked to deliver a lecture before the Sanitary Congress at Bolton, I felt some little hesitation in bringing before it the subject of the Prevention of Consumption.

The prevention of disease is indeed the aim of all sanitary reformers, and I had little doubt as to the acceptability of an address aiming, with any likelihood of success, at the prevention of a disease of such importance as consumption.

But this was just the point at which some misgiving would creep in, and the question would arise as to whether there was sufficient evidence of the preventability of tubercular disease, as to justify me in bringing the subject before the members of this great Institute.

I think there is, but before venturing to bring my views before this meeting, I thought it well to ask for the permission of your council.

This permission has now been freely given to me, and I must therefore, proceed to defend my thesis as well as I am able—and lay before you the reasons for my faith, and my grounds for thinking that this fell disease, the “scourge of England” as it has been called, may reasonably be called preventable, and by what means it may be prevented or at least be limited in its range.

I need not dilate much upon the magnitude of the task before us. About 70,000 persons die every year of tubercular disease in England and Wales, and as the average duration of the disease is now about three years, this means that there are

nearly 200,000 persons in the country constantly suffering from the complaint.

How fatal consumption is to the adult part of the population, may be judged from the fact that more than a quarter of the total deaths between the ages 15 and 65 are caused by it, and nearly half between 15 and 35.

“To see it down in figures on a page,  
Plain, silent, clear, as God sees through the earth  
The sense of all the graves, that’s terrible  
For one who is not God, and cannot right  
The wrong he looks on.”

AURORA LEIGH.

It is the working years of men’s lives that are chiefly affected by consumption. It is the malady of youth and middle life, and thus interferes more than any other with the economy of the State.

It carries off the most efficient of the population in the prime of manhood or of womanhood, and many of them are those who have given bright promises for the future.

Consumption often carries off the flowers of the flock—the most intelligent, the comeliest, the bravest and the best. They are cut down before they have accomplished a tithe of the great things of which their talents have given promise. Few can have failed to notice that many of those promising young people who have been thought worthy of biographical fame have finally succumbed to the onset of this fell malady.

The very magnitude of the work before us, and its extreme importance, is indeed the best excuse that I can give for bringing it before you; and if it can be proved to be within the bounds of possibility that such a disease can be prevented, the greatness of the task ought surely to be an additional incentive to attempt it, according to the Latin saying, “dignus vindice nodus.”

But up to quite a recent period, not only was consumption deemed to be incurable, it was also regarded as almost inevitable. Families in which existed the taint of the disease were supposed to be doomed: a certain number of them were certain to succumb to the hereditary curse.

Insurance offices still refuse to enrol amongst their members those who have lost father and mother from the disease, and even collateral relatives who have died from it are judged to have an influence upon the life of the candidate for life assurance. It was also common amongst workpeople who worked at unhealthy trades, such as steel-grinding, glass-cutting, mining, &c., to regard the mortality from consumption amongst them as only natural and part of their fate. A fork-grinder once said to Mr. Hall, of Sheffield, “I shall be thirty-six next



month, and you know that is getting an old man at our trade." And another, a young man of about twenty-six years, said he "reckoned in about two more years at his trade he might begin to think of dropping off the perch;" adding, "You know a knife-grinder is an old cock at thirty."

Whilst these forebodings were held with regard to those who came of a consumptive stock, and those who followed certain trades, the fate of the consumptive himself was regarded as hopeless.

In my student days I have over and over again seen physicians regard the stethoscopic sounds that revealed the commencement of tubercle, as equivalent to a sentence of death, and even the late Sir Thomas Watson, in his classical work on the "Practice of Physic," says: "The tubercular disease when established is beyond our power." (Vol. II. p. 201.)

Niemeyer again remarks: "Many a patient gets well, who would formerly have been assumed to be a victim of tubercular and therefore incurable disease. I am fully convinced from my own experience of the last few years that in former times I lost many a patient from galloping consumption, only because I considered him lost from the very first." (Lecture on Consumption, p. 65.)

Even before the discovery of the bacillus of tubercle, these views of the inevitable character and the incurability of consumption were already beginning to be doubted.

It was shown by Dr. Pollock, in his work on the "Elements of Prognosis in Consumption," that: "Many cases which were given up by doctors, but outlived the prediction to arrive at old age, were undoubtedly recoveries from phthisis. Many more were instances of an early invasion of the disease with subsidence of the symptoms and long tolerance of the deposit" (p. 68). Again, he says: "I have many times witnessed all the phenomena of deposit, and all the symptoms of phthisis entirely removed" (p. 117). "The best authorities lean to the opinion that tubercle is capable of removal by absorption" (p. 119.)

Dr. T. C. Williams remarks that the animal matter of tubercle may be absorbed; and Dr. Carswell says, "the curability of this disease has in my opinion been settled by Laennec"; and my old master, Dr. Stokes of Dublin, says, "there is no doubt that modern practice has proved the curability of phthisis," adding, "it is probable that many more cases of phthisis recover than is supposed." (Lectures in 1835.)

I have myself seen many cases of what might fairly be called cure, seeing that the patients lived thirty or forty years after undoubted cavities had formed in their lungs. Still more frequently have I recorded cases in which incipient disease had been arres-

ted, and no physical signs were to be found afterwards in the lungs. Within the last twenty years also it has become evident that there has been a distinct diminution in the death-rate from phthisis throughout the country.

In the three years, 1858 to 1860, the annual rate of mortality from consumption per million of persons living was 2567. In 1884 it was only 1818, a diminution of 749 per million, or a total saving of about 20,000 lives every year.

Nor is this improvement confined to England. "In 1857, 39·50 deaths from consumption were returned in the State of Massachusetts for each 10,000 of the population; in 1883 only 29·90. This decrease is too large to credit to greater accuracy in diagnosis and to the transference of consumption to other States, and is mainly attributable to the prevention of phthisis by improved hygiene." (Strumpel. Text Book of Medicine, p. 213.)

Evidence has also been forthcoming of the strongest kind, of the influence of sanitary measures, and especially of good drainage and good ventilation, as a preventative of consumption.

No better instance of this could be found than in the records of the mortality from this disease in the British army and navy. This evidence was collected by the commission on the sanitary state of the army, 1858, and the results are shown in the following table which has frequently been quoted before, but which can hardly be too often brought before public notice. This mortality is given at several stations for several successive periods, and I think that you will be at once struck by the enormous death rates amongst the troops in the earlier period, and at every one of the stations, and the great reduction of the rate in 1874, and at the present time it is still further reduced.\*

*Mortality per 1,000 of Strength.*

	1830 to 1837.	1837 to 1847.	1863 to 1872.	1874.
Household Cavalry . . . .	14·5	11·1	9.17	8·79
Cavalry of Line . . . . .	15·3	13·5		
Foot Guards . . . . .	21·6	20·4		
Mediterranean Stations..	21	16·4	11·2	7·27
Canada, &c. . . . .	23	17	9·49	6·0
Jamaica, &c. . . . .	91	59	17·05	16·9
Madras, India . . . . .	52	—	24·2	14·22
Bengal „ . . . . .	44			
Ceylon . . . . .	49	—	21·95	6·04

Rates of Mortality at the same ages prevailing in healthy country populations . . . . .	7·7
In England and Wales . . . . .	9·2
In Manchester . . . . .	12·4

\* In 1883 it was only 6·28 per 1000, and throughout the world only 9·57.

The greater part of this excessive mortality was due to consumption.

Dr. Buchanan, now medical officer to the Local Government Board, has also conclusively shown that good drainage of a locality may diminish by one half the prevalence of the disease, as in the case of the city of Salisbury.

These proofs of the preventability of consumption, were accumulated long before the discovery by Prof. Koch, that in most cases the disease originates outside the body, that it is due to the minute micro-organism named by him the bacillus of tubercle, and that its ravages are fostered by various external conditions, most of which are distinctly under the control of appropriate sanitary measures.

Since then it has become increasingly evident that Louis was right when he said, that "few persons were born necessarily to die of the disease," and it has been now abundantly proved that consumption is eminently a preventable disease.

But before proceeding at once to the inquiry how it may be prevented, let us for a few moments consider what tubercle is now ascertained to be. An amusing imaginary conversation given by Dr. McCormack, will serve to show the stride that has been recently made in our knowledge on this point.

"If you ask a pathologist what tubercle is, he will perchance reply, readily, that it is a certain deep-seated or, peradventure, superficial tumour which possibly tends to suppuration. You quietly remind him, that you do not ask where it is seated or to what it proceeds, but only what it really is. He will then, it may be, inform you that there are tubercles yellow, gray, and miliary, nay fibroid, induced by depressed vital powers, in short a defective decaying tendency in the bioplasm. You rejoin as gently as may be, that you do not care a button about their color or size, and as for depressed vital powers you consider that mere φλυαεία, since you only desire to learn what tubercles actually are."

"The pathologist now takes himself up a little, as a Frenchman might say, and briskly states that tubercle in fact is a morbid material which, being deposited on the mucous and serous surfaces and in the areolar tissues, destroys the elements which it implicates. In the excess of your courtesy you beg his pardon, and just remark that you do not want to learn where the material in question is deposited or what tissue it destroys, but only what it assuredly is. By this time our pathologist's colour becomes ever so little heightened; still he answers confidently that tubercle, as resulting from a pathological alteration, degenerates into an opaque, then a friable, lastly a purulent substance, which— But here you boldly



interrupt him with the observation that not yet has he replied to your inquiry as to the real nature and essence of tubercle. The pathologist, if he be a candid person, as pathologists commonly are, then confesses, as he might just as well have done at the outset, that he knows nothing whatever, the real nature of tubercle regarded, about the matter."

Fortunately we know something more than this now of the intimate nature of tubercle. Thanks to Prof. Koch we know that it is constantly associated with the presence of a micro-organism which, either by its own initiative power, or by means of the products of its activity, causes the formation of the bodies called tubercles within the textures of the body, that it makes its entrance from without, and that, once lodged within the frame, it travels infectively through it, chiefly along the course of the lymphatic system.

The conditions of its existence are briefly those to be found within the animal body—a certain degree of moisture, a temperature of about 37° Centigrade (from 86° to 107° F.), and a supply of nitrogenous food, such as blood serum will give.

If cultivated outside the body all these conditions must be imitated, and there is further the very important observation that it needs for its development a sojourn of at least a week, and sometimes much longer, in these conditions before it can take root, so to speak, and grow. Moreover, it is a being of very tenacious vitality, and it will preserve its virulence and capacity for development for six weeks or longer in decomposing tuberculous material, and for six months at least in a dry state. It also resists the action of many germicides.

Its close connection with tubercle has been proved, (1) by its almost constant presence in tuberculous cases; (2) by its absence in all other diseases; and (3) by pure cultivations of its colonies being injected into the body, causing tubercular disease of the parts inoculated.

Once in the body, there is unfortunately hardly a structure which tubercle does not implicate, a function which primarily or secondarily in its sequences it does not invade and derange. As Dr. McCormack forcibly says, "No tongue could narrate, no pen indeed declare its deplorably frightful ravages. The exquisitely beautiful fabric of the eye does not escape, much less with all their admirable mutual adjustments, the muscles, joints and bones. The entire living material fabric, this so magnificent handiwork of God, is in truth disintegrated, defaced, and destroyed. The interior and exterior tissues waste and wither, the fingers become misshapen, the nails curve over, the muscles both of organic life and the life of relation, no longer adequately nourished, lose their volume, the lung tissue, as



Rokitansky tells us, ulcerates and disappears. The breath is as if from a vault, and in laryngeal phthisis, the poor sufferer, spitting, choking, coughing, is perhaps carried off by suffocative spasm of the glottis at last."

Now, how may consumption be prevented? The answer to this question depends upon the reply to the further inquiry—what are the conditions that enable the tubercle bacillus to enter the body in a virulent form, and what further are those that enable it to do its deadly work there? As Cicero has aptly said, "Physicians consider that when the cause of a disease has been discovered, they have also discovered its cure." At least if this is not quite true they can often prevent it.

Let us first dispose of a number of influences, formerly supposed to be causes of consumption that have now been proved to have only a remote or doubtful effect upon its course.

1. *Climate*.—At one time it was supposed that climate was everything, both in the prevention and cure of consumption, but it has now been shown to be almost entirely without influence except so far as it permits or discourages an almost entirely open air life.

Wherever human beings are congregated together, in every part of the habitable globe, and in all climates, there is consumption to be found. It is as Dr. Lombard says "a ubiquitous malady."

It would almost be sufficient to point to the table of Army Mortality for the proof of this assertion, but I have also drawn up a table from Dr. Lombard's statistics showing its great prevalence in most of the capital cities of Europe, and in other parts of the world.

It will be seen that it is almost equally prevalent in the South as in the North, in the East as in the West.

Even in the places where there is the greatest exemption from the disease, in the desert, on high mountain ranges, and in Arctic or Sub-Arctic regions it is still to be found under certain unsanitary conditions. In Asia Minor it is often met with on the coast or in the principal towns. The Bedouins on the coast of the Red Sea, "who exchange their tents for stone built houses," suffer from it. In Syria it is met with at Aleppo, and in the Soudan at Khartoum.

In Algeria whilst the Nomad Arabs are free, "amongst the captives many die of the disease."

The same observations may be made regarding Australia and North and South America, including Canada and the Arctic regions.

Even in the high lands of Switzerland there is no complete immunity from the disease. Amongst those of the population

who are attracted to in-door employments, as Dr. Emil Müller has shown ("Distribution of Consumption in Switzerland"), a certain proportion die of the disease. Industrial in-door pursuits give rise to a rate varying from 6·5 to 10·2 per cent., and one of the highest of these rates, 9·8, is at an elevation of 3,400 to 4,400 feet. At 4,400 to 5,000 feet of altitude, in mixed labour the rate from the disease was 7·7 per cent.

Here, then, again we find the conditions of life a much more powerful influence than climate or elevation of site.

2. Take next exposure to cold, privation, and hardship of all kinds; only remotely are these causes of consumption.

It is true that there are still medical men who regard them as the chief agents in preparing the human frame for its ravages; thus Dr. Jaccoud affirms that the consumptive constitution is essentially one to "insufficient nutrition, taking this word in its widest sense," and Mon. Bouchardat, in his recent treatise on Hygiene, affirms that "the continuous loss of calorific elements, in any considerable proportion, leads to pulmonary tuberculosis," that it is due to some form of "*misère physiologique*."

But the Army Medical Reports again afford a sufficient answer to this hypothesis. The phthisis that at one time carried off so many of the finest soldiers of the British army, was not brought on by starvation, or privation, or exposure to hardship. It occurred for the most part when they were not on active service, but in the time of peace, when they were well fed and well cared for in every material respect, far better in fact than the half-starved artisans and agricultural laborers, who only died at one-third the rate that they did.

Again, the poor fishermen of Iceland, and the hunters and trappers of North America, the nomad tribes of Asia and Africa, the wretched natives of Australia, all these people escape the disease almost entirely, whilst half the deaths of the well-protected, well-clothed, adult inhabitants of towns, are from this cause.

The Highlanders who inhabit well-built houses on the mainland of Scotland are subject to the same rate as the other inhabitants; whilst the ill-fed, ill-clothed fishermen of the Hebrides, who are of the same race, hardly ever contract the disease.

It is quite true that inflammations of the respiratory apparatus, especially of the tissues of the lungs and pleura, constitute a remote or predisposing cause of consumption. These diseases are apt to destroy the natural elasticity of the lungs and render them unable to dislodge or to destroy the micro-organism which may succeed in finding an entrance into them, and which thus may plant itself firmly into their substance, irritating them and ultimately leading to consolidation and subsequent softening.

If the conditions are such as to lead people easily to take cold, and if they thus produce what is called chronic catarrhal pneumonia, they leave a condition of the lungs that both facilitates the lodgment in them of the tubercle bacillus, and also prevents its expulsion or destruction by the natural forces of the human economy. Some physicians believe that nearly all cases of phthisis commence in this way. Niemeyer says, "Tuberculosis is in most cases a secondary disease," p. 15; and Dr. Herman Weber observes, "A fruitful source of phthisis is the tendency to catarrh of the respiratory mucous membrane;" and he further points out how these catarrhs may lead to phthisis: "(1) By producing numerous mucous abrasions upon which the bacilli can settle; (2) by weakening epithelial cells and their ciliary action; (3) by rendering respirations more shallow; and (4) by weakening the nutrition and energy of the whole system."

In the light of modern research it is not difficult to understand why a loss of elasticity of the lung should lead to consumption. We have seen that the bacillus of tubercle needs for its development a sojourn of at least a week in contact with suitable nourishment, and at a temperature nearly approximating to that of the human body. It is also highly probable that in all towns and places where men most congregate some of these infective particles are present in the atmosphere, but they are for the most part quite harmless to healthy persons. One reason why they are thus harmless may well be the difficulty with which these particles could make their way along the air passages of the lungs of such people. They are constantly liable to be arrested on the moist surfaces of the mucous membrane; and, if they are once caught in this way, they will soon be passed out of the chest by the delicate "cilia" that line the tubes. Even if they should penetrate into the ultimate lung tissues also, they are likely to be destroyed by the fresh blasts of air that rush freely into every portion of a healthy lung.

These safeguards, however, are not present in lungs that have either been compressed by constrained postures, or that have lost their elasticity through inflammatory actions. The germs of the disease, therefore, if they can penetrate the inactive portions of such damaged lungs, may both find there suitable food and warmth, and may rest long enough to develop true tubercular irritation.

In complaints such as simple catarrh and bronchitis, in which there is a copious secretion of mucus, I am inclined to think that there is less reason to fear a permanent lodgment of the bacillus. This organism is, in fact, likely to be entangled in



the frothy secretion, and to be expelled along with it before it can do harm.

Some years ago, in an enquiry into the nature and quantity of the organic matter of the breath, I was much struck with the fact that in bronchitis and catarrh, and other diseases in which there was much expectoration, the proportionate amount of this substance exhaled in the aqueous vapour from the lungs was only one half of that from healthy persons; not that there was really less organic matter thus excreted, but because it was taken up by the mucus before it could reach the mouth.

Professor Tyndall has also shown, by means of his illuminated tube, "the filtering action" of the lungs—all dust inhaled being caught up by the bronchial secretion and prevented from appearing in the expired air. It would equally be prevented from travelling into the air cells. Something of this kind must always go on in such diseases as those in question.

But even in chronic bronchitis, after a time, the expulsive machinery may become defective, the waving cilia may become less active, the muscular apparatus of the tubes may be weakened, and dilatation and plugging of the air passages may occur; thus the bacillus may find a lodgment within the lungs, and true tubercular disease may be set up. This specific infection is again still more likely to take place if from any cause the ultimate tissues become inflamed, as in the various forms of catarrhal-pneumonia or broncho-pneumonia. In this case, even more than in simple catarrh, the lung loses its elasticity, its tissues are more open to infection, the residual air becomes stagnant, and its impurities, including foreign germs, are liable to be imprisoned for an indefinite time. In such a sense as this then, the causes of inflammatory diseases of the chest are also the causes of consumption.

But is exposure to the elements as fruitful a cause of cold-catching as is commonly supposed? Do we find that men who are much in the open air are more likely to take cold than the inmates of well warmed and well closed apartments? Quite the contrary. Soldiers on campaign, sailors, fishermen, hunters, gipsies, engine-drivers, coachmen, gardeners, agricultural labourers, none of these people suffer much from catarrhal affections, unless they are intemperate. To quote again from Dr. McCormack (p. 40), "Arctic explorers, supplied indeed with food and clothes, confront with perfect equanimity the chilliest air that ever flowed. Whymper safely slept, he tells us, *sub divo*, in chill Alaska, with only a screen to windward, when the mercury in his barometer was frozen hard. Von Wrangel relates quite a similar experience in respect of the dwellers by the shores of the Arctic ocean."



It is interesting to notice also the immunity from cold exhibited by our volunteers when they camp out for a week or a fortnight, and the instance has the more value because most of these men are unaccustomed to an open air life, and have for the most part of their days been the occupants of close offices or stuffy warehouses.

I have known men to be thus exposed for a great part of their time not only to cold, but to drenching rain, with pools forming under their beds in the tents, and yet not a single man in a battalion has been invalided from the effects of cold.

On the other hand we know that the inhabitants of towns not only contract diseases of the lungs, but die of their consequences in excessive numbers. It has been calculated that in Manchester people die of these complaints at more than three times the rate that they do in breezy Westmoreland. Mere exposure to cold, and hardship, and privation, are not therefore to be reckoned as causes of consumption.

3. The next supposed cause of consumption to which I shall allude is the inhalation of irritating substances, or dusts arising from works of various kinds, such as steel grinding, glass cutting, brush making, &c.

In the year 1858, Dr. Headlam Greenhow presented to the Privy Counsel a report in which he pointed out the influence of occupation as a cause of pulmonary diseases. In 1860 and 1861, he returned again to the subject and dwelt especially upon the large mortality from these complaints, amongst those who worked in an atmosphere impregnated with dust consisting of fine particles of metal or of sandstone, &c.

His statistics, although very valuable in many ways, are nevertheless open to criticism in reference to the causation of consumption. He groups together many very different forms of lung affection—many that are not tuberculosis at all—and he was not able in many cases to discriminate between the effects of the occupation itself, and those of the conditions under which it was carried on.

No one, indeed, who has studied the vital statistics of these occupations, or who has medically attended the workpeople, can doubt the power of irritating dusts in inducing a state of the lungs that is favourable to the reception of the specific organism.

Just as in the case of lungs otherwise injured, tubercle may readily be engrafted upon a miner's or a needlemaker's lung; but the disease that is first caused by the particles these men inhale is not tuberculous at all. It is simply a chronic inflammation, affecting chiefly the connective tissue and the formation of a fibroid tissue in the alveolar wells. It leads ultimately to a contraction and, so to speak, a strangling of certain portions

of the lung tissue. But no bacilli are found in either the tissues or in the expectoration of such patients, as I can testify from frequent stainings.

I have myself watched many of these cases affecting persons who have lived under otherwise healthy conditions, and although they have ultimately succumbed to the exhausting effects of the disease, yet from first to last they have kept free from the infection of tubercle. The cirrhosis, or fibroid disease, as it has been called, never degenerated into true consumption.

Dusts, therefore, although they are a serious danger, and though they ought on this account to be kept away from work-people as a preventive measure against consumption, yet are only remotely a cause of the disease. Much the same must be said of stooping postures during work.

4. I would say a few more words on the subject of hereditary predisposition to the disease.

That this is a real source of danger no medical man would deny. Thus we have seen instances of families in which almost every member has died of the disease, and others in which members of the same family living in different and far distant places, have yet one and all ultimately succumbed to it. In every such instance however, so far as I am aware, something has been added to the mere vulnerability of the persons attacked, either residence in confined air, repeated attacks of cold or some other assisting cause. And such a tendency to contract the disease can only be regarded as a remote and not as an essential cause of consumption. There is no need to assume the existence of a tubercular constitution any more than there is for affirming that there is a diphtheritic or typhoid constitution when a family is unusually predisposed to these disorders.

I know, for instance, of one family in which six out of eleven children have died of diphtheria, and other members have suffered from the complaint. They were not all struck down at the same time or by the same epidemic, but three children died in one place, one at another, and two in the village where they are now residing. Such a fatality as this from a particular disease means nothing more than a tendency to contract it, and a readiness to give way before its attacks.

It is, moreover, highly probable that heredity has much less to do with consumption than is commonly supposed. A very large proportion of cases arise without any phthisical family history in the past. Many healthy families leaving the country and coming to reside in crowded towns lose some members subsequently from consumption. In the army more than 60 per cent. of cases are non-hereditary. Even when we take the the difficult test of statistics we find they are apt to be deceptive.

Thus Briquet found that one-third of the consumptive patients at a hospital were born of consumptive parents on one side or the other; Dr. Quain 25 per cent; Dr. T. C. Williams 12 per cent. of direct influence, and 48 per cent. of family predisposition. But in these figures no account is taken of the influence of external circumstances, circumstances that are common to all the members of the family.

Again, there are so many deaths from phthisis in the country (as I said before, about half of all the deaths between the ages of 15 and 35 are due to this cause), and hence, without any such thing as hereditary taint, there would be nothing surprising in the fact that half of the consumptive patients have had consumptive relatives.

Dr. Walshe, the chief authority on chest diseases in this country, obtained from his hospital patients the result that about 26 per cent. came of a father or mother, or of both parents similarly diseased; but in discussing the significance of these figures, he asks whether they prove the reality of hereditary influence, and decides that they do not. "This ratio," he says, "of 26 per cent. might be, and probably is, no higher than that of the tuberculized portion of the population generally," and he concludes that "much phthisis is, in each generation, non-hereditary."

In any case it is highly probable that this influence has been greatly overrated. If the true causes of consumption are avoided, even those who come of a consumptive stock will escape the hereditary curse. As Louis says (*Recherches sur la Phthisie*, p. 532): "Nous n'avons recueilli aucun fait en faveur de l'hérédité de la phthisie."

We are now prepared to consider certain conditions that seem to be more essential to the virulent activity of the micro-organism, and

(1) I would mention bad drainage of soils upon which houses are built.

The Commission on the sanitary state of the army in 1858, whose report I have already quoted, combined as chief agents two causes, and affirmed plainly that "the ravages committed in the ranks of the army by pulmonary disease are to be traced in a great degree to the vitiated atmosphere generated by overcrowding and deficient ventilation, and *the absence of proper sewerage of barracks*. In 1864 Mr. A. B. Middleton also called attention to these two sources of danger in a paper read before the British Association at Bath, but in an independent enquiry conducted in 1862 in Massachusetts by Dr. Bowditch, the extreme importance of dampness of soil as a cause of consumption was insisted upon.



He came to the conclusion that—(1) “A residence on or near a damp soil, whether that dampness is inherent in the soil itself or caused by percolation from adjacent ponds, from marshes, or springy soils, is one of the primal causes of consumption in Massachusetts, probably in New England,” and possibly in other portions of the globe. (2.) Consumption can be checked in its career, and possibly, nay probably, prevented by attention to this law.”

Shortly afterwards, and without any knowledge of Dr. Bowditch's conclusions, Dr. Buchanan, who is now the chief medical officer to the Local Government Board, came to much the same conclusions as the result of an elaborate research into the distribution of consumption in the three south-eastern counties of England beyond the limits of the Metropolis.

His conclusions are well worthy of being quoted *in extenso*—they are as follow:—

(1.) Within the counties of Surrey, Kent, and Sussex, there is, broadly speaking, less phthisis (*i.e.*, consumption) among populations living on pervious soils than among populations living on impervious soils.

(2.) Within the same counties there is less phthisis among populations living on high-lying pervious soils than among populations living on low-lying pervious soils.

(3.) Within the same counties there is less phthisis among populations living on sloping impervious soils than among populations living on flat impervious soils.

(4.) The connection between soil and phthisis has been established in this enquiry—(a) by the existence of general agreement in phthisis mortality between districts that have common geological and topographical features of a nature to effect the water-holding quality of the soil; (b) by the existence of general disagreement between districts that are differently circumstanced in regard to such features; and (c) by the discovery of pretty regular concomitancy in the fluctuation of the two conditions, from much phthisis with much wetness of soil, to little phthisis with little wetness of soil. But the connection between wet soil and phthisis came out last year in another way, which must here be recalled—(d) by the observation that phthisis had been greatly reduced in towns where the water of the soil had been artificially removed, and that it had not been reduced in other towns where the soil had not been dried.

(5.) The whole of the foregoing conclusions combine into one—which may now be affirmed generally, and not only of particular districts—that “wetness of soil is a cause of phthisis to the population living upon it.”



(6.) No other circumstance can be detected, after careful consideration of the materials accumulated during this year, that coincides on any large scale with the greater or less prevalence of phthisis, except the one condition of soil.

These results have since been confirmed by Dr. Haviland, and by the Registrar-General of Scotland. In the conclusions drawn from his map of the distribution of phthisis in England and Wales, Dr. Haviland says: "Damp, clayey soil, whether belonging to the wealdon, oolitic, or cretaceous formation, is coincident with a high mortality;" and the Registrar-General, in his seventh report, remarks that "the towns, villages, hamlets, or houses which were situated at or near undrained localities, or were on heavy, impermeable soils, or on low-lying ground, and whose sites were consequently kept damp, had a very much larger number and proportion of cases of consumption than towns, villages, hamlets, or houses which were situated on dry or rocky ground, or on light porous soils, where the redundant moisture easily escaped."

The vapours that arise from damp ground, and which make their way into houses, are often very impure, and charged with organic matter that may be a suitable food for the tubercle bacillus.

In an address to this Congress, held at Leicester, the year before last, I gave the details of an inquiry into this subject that goes even further than those already cited—a contrast between two populations, one being on clay lands, the other on a hill of sand. The result was derived from a ten years mortality table, and was that whereas in this period there had originated forty-four cases per 1,000 inhabitants on the clay lands, on the sand only one per 1,000 had thus suffered, and that not one of the children or females of the population who were constantly resident there had contracted the disease. In this instance, however, we had only the influence of a dry soil to deal with; the houses were those of well-to-do people, and were fairly well ventilated. Whether there would have been the same immunity under other conditions is very doubtful.

Still it is evident from the facts before us that there is a close relationship between the condition of the soil and consumption—a relationship so close that, as we have seen, a residence on a porous soil, under otherwise favourable hygienic conditions, will apparently preserve the whole community from the disease.

It is further noticeable that in these cases hereditary predisposition made no difference in the result. There were present in these populations many whose parents or near relatives had died of the disease, and yet they did not contract it so long as they lived in the place. I think it may therefore be fairly

assumed that in a well drained, uncontaminated soil, we have one of the means by which consumption may be prevented.

2. But we still have to consider the most prolific source from which the bacillus of tubercle derives its virulence—a cause without which neither starvation, nor exposure, nor hard work, not even probably hereditary predisposition will bring on consumption. It is a cause that is common to rich and poor, that is to be found in all climates, in all collections of human beings, and that is only absent in the places where consumption is not to be found. In two words, it is *foul air*, and for the most part it is air that has been rendered foul by previous respiration.

It is to Dr. McCormack that we owe the most definite statement of this now well-recognized influence, and that as he says, “wherever there is foul air \* \* \* \* there we meet consumption, there we meet scrofula, and an untimely death.”

His further theory that tubercle is due to “carbon and other impurities inadequately discharged during the process of respiration” is now not tenable, but his demonstration of the danger of breathing air that has been breathed before is of none the less value.

Let me very briefly bring before you the grounds for this opinion.

1. We have the fact that increased density of a population means also increased general mortality, and especially increased mortality from lung disease. The late Dr. Farr was the first to establish this fact, and to reduce it almost to a mathematical demonstration.

In proportion as larger and larger numbers of persons are attracted to a certain limited area of ground, in that proportion, *cæteris paribus*, does the mortality from consumption increase.

It is true that we have along with this condition a combination of most, if not all, of the other circumstances unfavourable to health—poverty, insufficient food, low site and often damp ill-constructed dwellings; and we might with equal right select any one of these things as the true cause of the disease, but for the strong fact that all these things exist, in still greater intensity, in some country districts of England, or in the poorer villages of Scotland, along with a very low rate of mortality from consumption.

2. We have the evidence, that is now most ample, that in proportion as people are attracted to indoor occupation, and in proportion to the degree of closeness and bad ventilation of the places in which they work, in that ratio is the rate of mortality from consumption increased. This fact was first demonstrated by Dr. Greenhow in his statistical inquiry, but it has since been fully confirmed by other observers.

Any one who looks at the map of the distribution of consumption in England prepared by Mr. Alfred Haviland, must be at once struck with the deepening of colour that shows intensity of disease in the great industrial centres of the country. The influence of this cause is also shown by the contrast between the male and female rates of mortality in town and country districts.

In some parts of England the men are the chief workers at indoor employments—as in Sheffield and Birmingham; there you find the male rate the highest; in others, as at Nottingham, Huddersfield, and Macclesfield, the women are most employed, and consequently they die most numerous of consumption; and in places like Liverpool and Manchester, and Stockport, where there is little difference in the employment of men and women, there is also little difference in the rates of mortality from consumption; both are high.

But the most striking testimony is from the relative death-rates in the two sexes in country places, such as Market Drayton, Bakewell, Nuneaton, Camelford, and Pickering. Here, where the men are constantly out of doors, their consumption rate is uniformly low, while the women, who keep the house, die at a constantly higher rate of this disease.

3. We have the experience given to us by the records of the mortality from consumption in the British Army and Navy, and a similar history could be told of the European forces.

In the exhaustive report of the Commissions upon the Sanitary State of the Army, it appeared that lung disease was more than twice as fatal amongst the picked men who formed the army as it was amongst the ordinary civil population of the country (12·5 of the former to 5·8 of the latter).

They pointed out that in civil life, insufficient clothing, insufficient and unwholesome food, sedentary and unwholesome occupations, and the vitiated atmosphere of unhealthy dwellings, all contribute to the propagation of this class of diseases. But in the army it cannot be alleged that the clothing, the food, or the nature of the occupation in itself, are of a character which would justify the imputation that they are among the predisposing causes of the excessive mortality of the soldier by pulmonary disease. (Report of Commissioners on the Sanitary State of Army, 1858.)

I have already given their opinion as to the true causes of this contrast.

4. I have lately had occasion to examine into the distribution of phthisis in certain districts of Manchester and Salford, and have ascertained that in every case the parts of these districts most affected by the disease are the close courts and alleys, the shut-in streets, and especially the back-to-back houses.



5th and lastly. We may take an entirely different method of proof and we can show that wherever, in different parts of the world, there is an abundance of fresh air in the dwellings of the people, there is to be found a comparative immunity from the disease, even though most of the other surroundings are, in a sanitary point of view, almost as bad as they can be.

On the whole I think it may be regarded as fully proved that the breathing of air rendered foul by previous respiration is one of the conditions required to enable the bacillus of tubercle to take root and to grow in the lungs of human beings. Similar evidence is also forthcoming as to its influence upon animals—horses, cows, monkeys, &c.

It is important then to inquire what are the ingredients in respired air that are thus so potent for evil.

We can of course easily answer for one of them, and it might be supposed sufficient to account for all the facts that have now been brought forward. I mean the presenee of the tubercle bacillus itself. This must needs be present in such air, or the disease would not arise. It must come originally from the body of some tuberculous patient. It may have come directly from the breath, as it has been found in the watery vapour exhaled from the lungs of such persons; but it is more probably mixed up with the dust in the air, forming one of the innocent looking motes that dance in a sunbeam. It may have been at some time or other derived from the dried up excretions of some poor consumptive, by its inherent vitality outliving its victim; but the strange part of the story is that the micro-organism cannot do its work unless it is assisted by the presenee of other impurities. We cannot doubt that the creature is given out into well-ventilated, as well as into badly aerated spaces, and yet so far as we know it never communicates the disease in the former case.

How is it that in the wards of a consumptive hospital, or in the sick rooms of well-ventilated houses, it never attacks the attendants? Even in the confined dwellings of the poor direct contagion, in this country at any rate, is a very rare event, and where drainage and ventilation are good I have never heard of or seen any case of direct transmission, even where there has been ample opportunity for breath to infect breath, as in the case of husband and wife or sisters sleeping together.

So far as we know the only other components of expired air that could have any effect in enhancing the virulenee of the bacillus are the carbonic acid, the aqueous vapour and the organic matter that it contains in excess. But all these substances must be present under the eircumstances already spoken of, in which there is yet no direct transference of the disease



How, then, can these facts be reconciled with the overwhelming evidence that air rendered foul by respiration is one of the most powerful agents in producing consumption.

The explanation given by Dr. Koch is (1) the need for some preliminary injury to the lungs in persons who are about to act the part of hosts to these parasitic organisms, some denudation of the mucous membrane of the lungs, or some injury to the elasticity of these organs; and (2) the need of a plentiful supply of the infecting material.

The number of these microbes contained in the breath, even in advanced cases of phthisis is, as I can testify from repeated examinations, exceedingly small; but, on the other hand, the dried sputum from such patients contains them in enormous quantities. "This sputum is not only ejected directly on to the floor, there to be dried up, to be pulverised, and to rise again in the form of dust, but a good deal of it dries on bed linen, articles of clothing, and especially pocket-handkerchiefs, which even the cleanliest of patients cannot help soiling with the dangerous infective material when wiping the mouth after expectoration; and this also is subsequently scattered as dust."

I am doubtful myself how far this explanation would account for the exemption of the attendants of consumption hospitals from disease, and still more for the immunity conferred by residence upon well-drained porous soils.

It affords no reason for the diminution in the phthisis rate of Salisbury, for instance, by one half, after the introduction of proper drainage, and I am therefore inclined to believe that we have still not attained to a complete knowledge of the natural history of the microbe, and to venture the hypothesis that it may gain in virulence by a short sojourn outside the body, in the presence of organic compounds favourable to its existence, and contained either in impure ground air or else in air rendered foul by respiration; experiments need to be made on this point.

In this case the bacillus of tubercle would fall into the same category as the microbe of enteric fever and cholera, and whilst scarcely at all infective from person to person, it would gain the power of reproducing the disease by a sojourn for a shorter or longer time in some medium favourable to its development. If high temperatures are absolutely needed for its existence I am inclined to think that it would find them in some nook or corner in the common kitchens and living rooms inhabited by many of the poor inhabitants of our towns.

It is possible that all the components of expired air except the oxygen may take part in sustaining the existence of the microbe. I do not know whether the action upon it of carbonic acid has yet been ascertained, but it seems probable, from its continued existence in decomposing fluids, that it is one of

those bacilli whose life is fostered by this vapour. We can see at once also that aqueous vapours charged with organic matter would be eminently fitted to sustain its existence. The nature of the organic matter contained in the breath is not yet fully ascertained; it is probably partly gaseous and partly solid. I have myself examined it microscopically in a good many cases, both in health and disease, and have ascertained the quantity exhaled under various conditions. It certainly contains numerous solid particles; some of it simply disintegrated organised material, some dried up epithelial scales, and in some diseases, as in measles and whooping cough and phthisis, the specific organisms of the disease.

Its quantity is indeed very small, I found that only about 0·2 of a gramme is excreted per diem by healthy adults, or 0·4 gramme per metre of expired air, but this is 500 times as much as Dr. de Chaumont found in the outer air, and when condensed upon solid bodies it often forms a perceptible foully smelling film, and we know further from Dr. Hammond's experiments that it is virulently poisonous, and it would probably sustain the life of the bacillus though I am not aware of any direct experiments on this point.

We are now in a position to state the measures that are needed for the prevention of this terrible scourge of our population, and they may be thus briefly enumerated.

1. As far as possible the disinfection or destruction of the phthisical expectoration.

2. The discouragement of marriage between phthisical individuals.

3. The prevention of irritating dusts in workshops, or at any rate the adoption of means for sweeping them away from the mouths of workpeople, as is now almost universally done in the workshops of Sheffield.

4. The discouragement of stooping or confined postures during labour.

5. The better drainage of impervious soils, and the cleansing away of all kinds of filth.

6. The provision of thorough ventilation by night and day, not only in workshops, offices, warehouses, and factories, but also in the dwellings of both rich and poor, and in the streets and crowded alleys in which they live.

By the adoption of some such means as these I firmly believe that, in the course of time, we should see the present frightful mortality from consumption greatly diminished, and although they could probably be only partially carried out, every effort in the right direction would be rewarded by some improvement in the death-rate, not only from consumption, but also from other diseases, and especially diseases of the lungs.



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